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Food insecurity and coping strategies of low-income households in Tshwane, South Africa

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Abstract

This study used principal component analysis to provide targeted policy interventions in response to livelihood coping strategies adopted by low-income households in Tshwane (Pretoria), South Africa. The empirical findings are categorized into four food-coping strategy groups. The first group comprises households that depend on begging and borrowing to survive. The second group comprises households who use credit to purchase food and subsequently restrict their meals or skip them altogether. The third group comprises households that frequently borrow money to purchase food. These households prioritize buying necessities and sticking to a budget. These households also resort to selling assets to cushion against income shocks. The final group comprises households that do not have food gardens and rely on buying cheap, undesired food that they eat in smaller portions during their meal times. These findings raise concerns about the need for policies that increase household income and food access for the vulnerable urban population. Raising awareness about healthy and nutritious foods that can be obtained at a lower cost is also essential.

KEYWORDS

Coping Strategy Index, household food insecurity, low-income urban households, principal component analysis, South Africa, Tshwane (Pretoria)

INTRODUCTION

Sustainable Development Goal (SDG) 2 addresses poverty, food insecurity, and malnutrition. SDG 2.1 focuses on ensuring access to nutritious and balanced food with sufficient nutritional value, while SDG 2.2 aims to eliminate all forms of malnutrition. The African Union has committed to eradicating hunger and food insecurity in Africa while promoting food production through agricultural modernization by 2063. South Africa, with over 60% of its population living in cities, faces a massive challenge in feeding all of its urban population (Mazenda, Molepo, et al. 2022; Roisin et al. 2019). A lack of skills, high energy tariffs, and a regular rise in food and fuel prices exacerbate the condition. Coping with food insecurity is difficult because most products and services must be paid for in cash, and all food consumed is bought. On the other hand, agriculture does not play as significant a role in household subsistence strategies in cities as in rural areas (Mulamba, 2022).

Over 20% (1 in 5) of South African households are food insecure (Dlamini et al. 2023). Household food security is heavily influenced by sources of income, household structure, health, access to water, and education (Mulamba, 2022; Nenguda & Scholes, 2022).

The prevalence of food security varied widely across the provinces. The Eastern Cape province is the most affected (32%). All coping strategies are used to some extent. The most common strategy (used by at least 46%) is a reliance on less preferred and less expensive foods. Sending household members to beg for food is the least common strategy. It is used by almost 21% (more than 1 in 5) of households (Dlamini et al. 2023).

In Gauteng Townships, households mostly employ two coping strategies: buying cheap, undesirable food and consuming smaller portions of meals (Mazenda, Manzi, et al. 2022; Mojela et al. 2018).

In Tshwane, the majority of these households are unemployed, have menial jobs, and earn an average monthly income of about R1500 (US$79), which is often concealed in the overall median income of about R29,000 (US$1500) per household, indicating significant inequalities (Hamann & Horn, 2021; Mazenda, Molepo, et al. 2022). A lack of skills, high energy tariffs, and frequent increases in food and fuel prices exacerbate this situation.

The issue of managing food insecurity is a complex one that poses a challenge because all food is acquired with money. In urban areas, household survival strategies do not rely heavily on agriculture as in rural areas, making it even more difficult to access food (Chakona & Shackleton, 2019). The lack of food, particularly when coupled with a scarcity of financial resources to purchase it, puts nutritional safety at risk.

The paper responds to the following questions:

RQ1. *What is the overall state of food insecurity in Tshwane?*

RQ2. *What are the primary coping mechanisms adopted by the Tshwane low-income households in response to food insecurity?*

RQ3. *How do the coping patterns of the Tshwane low-income households relate to food insecurity and nutrition safety?*

While several studies have investigated food insecurity and its coping mechanisms in South African rural areas, few have explored coping mechanisms in cities. Of the few studies targeting cities, black townships, and informal settlements are emphasized. A similar pattern is evidenced in Tshwane (see Akinboade & Adeyefa, 2018; Mazenda, Manzi, et al. 2022; Mojela

et al. 2018). Of the studies targeting Tshwane, none have investigated food coping mechanisms adopted by households to cushion against food insecurity in all seven regions of Tshwane. Prior validated national surveys do not capture questions that focus on food coping strategies, including on the indicators required by the global Food and Nutrition Technical Assistance Program. This study adds to the literature by exploring the food security and coping mechanisms amongst low-income households in Tshwane. Consequently, a principal components analysis (PCA) was utilized to explore such behavior patterns, in contrast to multivariate regression techniques adopted by previous studies, which is a methodological contribution.

The rest of the paper is structured as follows. After the introduction, a literature review on household food coping strategies is presented. The materials, methods, results, discussion, policy implications, and conclusions follow.

LITERATURE REVIEW

The study utilized Huston's social-ecological theory to understand the household adaptation strategies to food insecurity in Tshwane. The theory highlights the person-environment interaction, the need to improve people-environment transactions and nurture human growth and development in specific environments. Sohel et al. (2021) applied the theory to explain the food-coping strategies adopted by indigenous households during COVID-19 in Bangladesh. The theory identifies three levels of analysis, including group, interpersonal relationships, and individual coping approaches, to appraise the coping mechanisms.

On the three levels of analysis, group-level analyses suggest that low-income households in vulnerable areas receive support from both official and unofficial sources to cushion against food insecurity. Interpersonal relationships, such as those within families, neighbors, and friends, are considered a crucial second level of support. This family level of assistance aids the heads of households to provide food for their children. Sometimes, household members might seek loans from friends or sell properties to meet their needs. Coping mechanisms at the individual level are also important. They can involve consuming less food, cutting expenses, altering food habits, and foraging for food in forests or hills to reduce the household burden.

Most people in low- and middle-income countries live with household food insecurity, which entails a shortage of wholesome, safe food and a constrained capacity to obtain food in ways that are acceptable to others (Militao et al. 2022). Global empirical research on household adoption of food security coping mechanisms emphasizes coping mechanisms in response to income shocks caused by droughts, floods, chronic conditions, pests, or diseases, among other factors. Assets and consumption thresholding/smoothing are two broad strategies for coping with such income shocks (Ansah et al. 2021). However, there is no discernible difference between asset coping strategies and consumption thresholds. For asset thresholding, households keep capital and wealth to generate profits. Asset threshold strategies are often ex-ante interventions with low transaction and opportunity costs, enabling households to absorb shocks in the shorter term (De Loach & Smith-Lin, 2018). Other studies examine ex-post asset thresholding techniques like reducing intake or missing meals (see Tesha, 2020; Tsegaye et al. 2018). To compensate for the income loss due to crop failures, households cut back on the number of meals they eat per day and only purchase necessities. Households accumulate assets in good times and deplete them in bad times to aid food purchasing or smooth consumption (Ricci, 2019). Komarek et al. (2020) and De Loach and Smith-Lin (2018) distinguish between productive assets, such as livestock and land, and non-productive assets, such as cash savings

and stored grains. Households experiencing a health shock, such as sickness, may sell livestock or use their savings to smooth consumption. When confronted with a crisis, some households reduce consumption by depleting livestock or grain stocks. (Doss et al. 2018). Households can also smooth consumption by working off-farm. Off-farm income comes from extension services, processing, packaging, storage, transportation distribution, and retail sales. (Moller et al. 2019).

Households with more properties are more stable and better able to cope with shocks. The severity of the shocks determines the assets to sell (Tongruksawattana & Wainaina, 2019). Consequently, when climate shocks interact with health, pest, or price shocks (incremental effect), the risk of household assets being exhausted to cope increases (Ansah et al. 2021).

From a developed country's urban perspective, Bezuneh and Yiheyis (2020) found that most households in Atlanta, Georgia, USA, delay the purchase of nonfood items, borrow money, and ask for food from relatives in response to hunger. One in seven people in the United Kingdom were recently found to be hungry because they cannot afford spiraling food costs; about 1200 households in the area rely on food banks, and some children skip meals (Bancroft, 2023; Kennedy & Cameron, 2022).

In Australia, financial hardship often results in food insecurity, mainly due to low wages, unexpected bills, or inadequate government support payments. As a solution, households often rely on food banks. In the Tasman region, effective coping strategies have been developed, including balancing interstate and international food exports with local needs, strengthening local food systems through collaboration and connections between food producers and consumers, and advocating for well-funded initiatives that build a community's capacity to respond to food insecurity challenges. This includes nutrition and food literacy programs that promote self-sufficiency in food production (Kent et al. 2022).

The Swedish City Mission and other organizations have seen a significant increase in the number of people seeking food assistance, with two-thirds of their recent efforts focused on subsidized meals, food bags, or food vouchers. The pressure on these organizations is so huge that some have temporarily closed their operations (Eurodiaconia, 2023).

This study hypothesized that food price shocks and the socioeconomic characteristics of households determine the food coping mechanisms that households adopt in the presence of food insecurity. Price shocks affect the real incomes of the households, which affects the affordability of foods on offer. A conceptual framework that links these influences and shocks and the socioeconomic characteristics of households to the food coping mechanisms households adopt for the desired outcome of enhanced food security is presented in Figure 1.

Though South Africa is food secure at the national level, food insecurity at the household level is prevalent (Nenguda & Scholes, 2022). The determinants are primarily socioeconomic, food price and income shocks, and the relevant public policy framework (social grants). This is similar in all South African municipalities, including Tshwane, as evidenced in Mazenda, Molepo, et al. (2022) and Tesfamariam et al. (2018). In response to food insecurity challenges, in particular food availability and affordability challenges, urban households respond by adopting a range of coping strategies clustered into five major components (buying cheaper foods, consuming smaller portions, limiting their budget, buying only necessities, and using credit for purchases) (Bahta & Musara, 2023; Crush & Frayne, 2018; Devereux, 2017). Tawodzera (2016) argued that urban households use harmful coping mechanisms to counter food insecurity, including borrowing from friends and family and selling personal goods and productive properties. Similarly, Battersby (2011) argued that coping strategies can be limited in urban areas. In a 2011 urban Cape Town study, only 19% of households used more than two

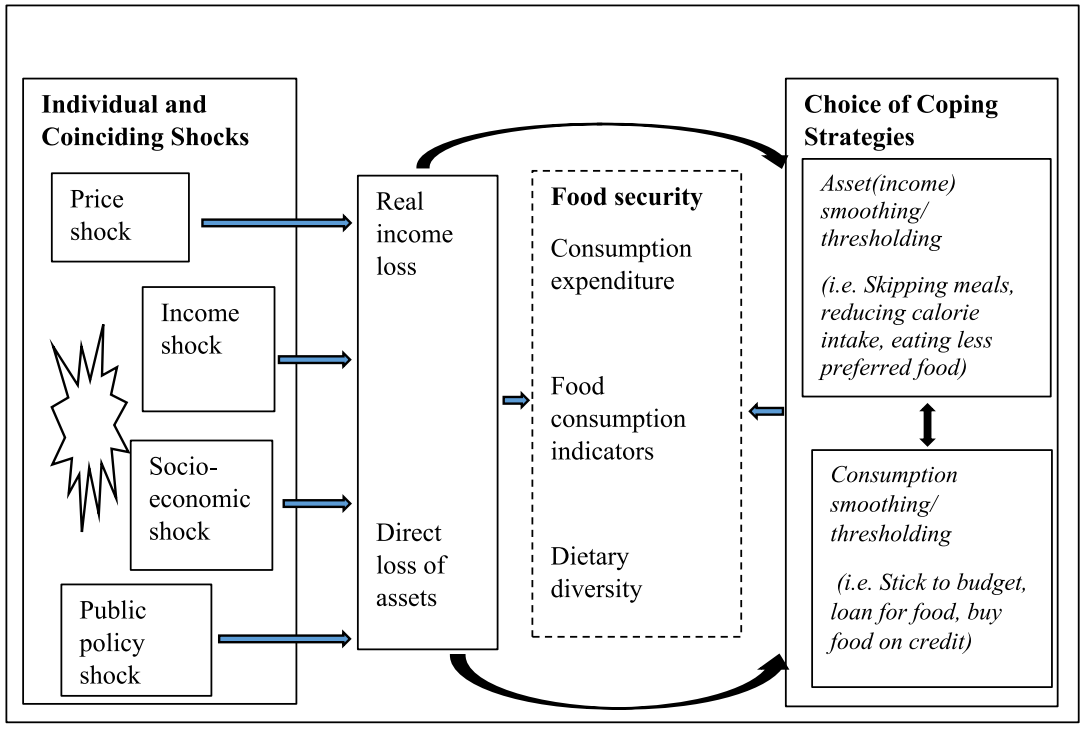

FIGURE 1 Conceptual framework of household food coping strategies adopted by Tshwane households. *Source*: Authors.

food coping strategies. About 50% of the households reported use of coping strategies due to limited employment opportunities to supplement income. Common coping mechanisms involve adjusting the cash commitment to food or the quantities purchased and consumed in a given period. These findings are reinforced by studies from other developing countries (see Danso-Abbeam et al. 2023; Militao et al. 2022; Negesse et al. 2022; Nenguda & Scholes, 2022; Nickanor et al. 2023). The authors reported the prevalence of rationing strategies consistent with low-income households, mainly skipping meals, borrowing, and sticking to a budget. When accounting for income-related shocks like COVID-19, a study conducted by Sohel et al. (2022) revealed that many households faced difficulties acquiring daily food. These struggles manifested in various ways, such as decreased food consumption, rising food prices, a crisis in food availability due to income loss, malnutrition, a shift towards unhealthy eating habits, and insufficient food, all resulting in mental stress and hunger.

While several studies have investigated food insecurity and its coping mechanisms in South African rural areas, few have explored coping mechanisms in cities. Of the few studies targeting cities, black townships, and informal settlements are emphasized. A similar pattern is evidenced in Tshwane (see Akinboade & Adeyefa, 2018; Mazenda, Manzi, et al. 2022; Mojela et al. 2018). Of the studies targeting Tshwane, none has investigated food coping mechanisms adopted by households in all seven regions to cushion against food insecurity. This study adds to the literature by exploring the food security and coping mechanisms amongst low-income households in Tshwane. Consequently, PCA was utilized to explore such behavior patterns, in

contrast to multivariate regression techniques adopted by previous studies, which is a methodological contribution.

MATERIALS AND METHODS

The study analyzed two datasets. First, the Quality of Life Survey Data (2021) was sourced from the Gauteng City-Region Observatory, to determine the degree of food insecurity in Tshwane. While this survey provided helpful information regarding the degree of food insecurity and food distress in Tshwane, it did not consider questions about the coping strategies of the low-income households that were found to be food insecure. This, therefore, necessitated the analysis of an additional data set. Second, we analyzed data from the Tshwane cross-section survey conducted between June 1 and June 30, 2019. A proportion of Tshwane's low-income households were enumerated based on their choice of various food coping strategies to cushion against hunger in the 7 days preceding the day of enumeration. The sample consisted of 775 households from the seven city regions subdivided into clusters. The households were targeted at the ward level following the methodology employed by Statistics South Africa during the Community Survey (Statistics South Africa Stats, SA, 2016).[1] A two-stage sampling scheme was adopted to ensure representativeness and cost-efficiency, with the first stage involving the selection of clusters using the probability proportional to size (PPS) scheme without replacement (WOR) and the second stage involving systematic sampling of households with a random start in selected clusters. The study included 73 clusters using PPS WOR and used a fixed systematic household sample with a random start of 15 per cluster. Clustering was critical for reducing the cost of enumeration. This strategy limits the physical movement of the enumerator from one stage of a sample to another (Kumar, 2014).

Data analysis involved a descriptive analysis and an empirical analysis. The descriptive analysis was based on the Quality of Life Survey Data (2021) to determine the food insecurity status of Tshwane households. The empirical analysis utilized PCA to present the food coping strategies extracted from the Food and Agriculture Organization's (FAO) Livelihood Coping Strategy Index (CSI). The index shows the magnitude of food insecurity among the population. It serves as an indicator for avoiding a food crisis and defining demographic groups needing intervention about the level of need, particularly the prevalence of malnutrition among the population (Maxwell & Caldwell, 2008). Attitudinal statements describing actions taken by households to deal with situations of food insecurity were adapted and included in the questionnaire and posed to the respondents.

The empirical model

The PCA was used to analyze Tshwane's low-income households' food coping patterns utilizing the CSI indicators developed by the FAO project in 2003. The choice of food coping strategies drawn from the CSI has 15 nominal levels, which is the probability of a household choosing any of the household food coping strategies in the 7 days preceding the interview (i.e., buy cheap undesired food, borrow food, eat a smaller portion at meal times, restrict eating by adults, skip meals, buy food on credit, obtain a loan for food, buy only necessities, stick to the budget, maintain a food garden, members eating somewhere, feeding only working members, sent household members to beg, gather wild vegetables and/or insects, and selling personal articles).

The PCA is a technique widely used in exploratory data analysis dealing with multicollinear data, which cannot be captured by general regression analysis (Casal et al. 2021; Hess & Hess, 2018). The PCA is a data analysis technique used to extract the few orthogonal linear combinations of variables that most efficiently capture standard information from a collection of variables by translating these interconnected parameters into a new range of non-correlated variables called the main components. (Anyadike, 2009). PCA reduces data complexity by grouping many measures into smaller, related groups. Each group identifies the underlying dimension of the contributing variables forming a group. (Yang, 2015). The basic formula for the PCA are as follows:

$$C_j = \beta_{J1}X_1 + \beta_{j2}X_2 + \ldots + \beta_{jm}X_m,$$

where C_j is the first component extracted, β_{jm} is the component loading of the jth variable on the mth component. PCA accounts for the total variance of variables, with components reflecting the expected variance of variables (Hess & Hess, 2018). In sum, the PCA-observed variables are relatively error-free. The unobserved latent component is a perfect linear variable suitable for data reduction (Hess & Hess, 2018).

This PCA allows for translating the original coping mechanisms into new coping strategy predictor variables, referred to as principal components (PC) while retaining as much specificity as possible. For example, the first transformed PC explains the most about food coping strategies, while subsequent PCs explain less about the same food coping strategies. The variables are standardized to quantify the principal components (Mean = 0 and Standard Deviation (SD) = 1). The key components, extracted from the correlation matrix calculated on standardized variables, become eigenvectors.

The Kaiser criterion measures the number of significant PCs, which states that only Eigenvalues greater than 1 are maintained, and loadings greater than 0.3 are interpretable (Tabachnick & Fidel, 2001). Another benefit of PCA is that each PC is uncorrelated, capturing specific information from within each of the household's adopted food coping strategies.

The factor loadings are analyzed using factor analysis. According to Kieffer (1998), the initial loadings are spurious since they do not constitute an "easy structure." To improve interpretability, the PCA used the Promax (oblique) rotation, which was inspired by Gorsuch (1983) and McLeod et al. (2001). The Promax rotation attempts to match a target matrix with a straightforward structure. If the basic structure is clear, more common procedures can yield the same results (Bro & Smilde, 2014; Gorsuch, 1983; Hess & Hess, 2018, p. 205).

RESULTS

This section presents the results of the study. The first section provides a descriptive analysis of the socioeconomic determinants of household food security and the food coping strategies adopted by Tshwane urban low-income households. The second section presents the PCA (PC) findings.

Descriptive analysis

This sub-section evaluates the characteristics of the socioeconomic determinants of food security status and the food coping strategies adopted by Tshwane, urban food insecure households. The

analysis of the Quality of Life Survey Data (2021) showed that food insecurity is a problem that requires attention in Tshwane. The data showed that 22% of the households indicated that there had been a time when an adult had to skip a meal because there was not enough money to buy food. More so, 32.4% of households that indicated a time when an adult had to skip a meal also recorded dissatisfaction with the food they eat overall, compared to only 9.3% of the households that never had a time when an adult had to skip a meal. Overall, the authors' calculations using the Quality of Life Survey Data (2021) indicate that 45% of households in Tshwane expressed some form of food distress. These findings point to the need to understand food-insecure households' coping strategies to leverage policy design that alleviates their food insecurity.

Determinants of household food security

Most of Tshwane's households are run by female household heads, who constitute 62% of the population. Household size ranges from 3 to 6 members, and household heads are generally aged between 31 and 39 years. In general, household income levels were low, with about 50% of households earning a combined income of less than R3500 (US$ 214) per month, a key indicator of food insecurity. This is accompanied by a decrease in access to social security grants. Approximately 47% of households do not have access to household social support. Access is concentrated in child and elderly welfare, affecting 30% and 19% of households, exposing most of the population. The descriptive analysis of the socioeconomic determinants of household food security is presented in Table 1.

Household livelihood food coping strategies

Low-income households adopt various coping strategies in response to shortfalls in access to food or money to buy food. Most of these strategies are embedded in the FAO's Livelihood CSI. The index is derived from a series of questions on households' experiences in the past 30 days. The strategies are classified into three broad categories. First, stress-level strategies, such as borrowing money and spending savings. Second, crisis strategies, such as selling productive assets, directly reduce future productivity. Finally, emergency strategies, such as selling land or livestock, affect future productivity but are more difficult to reverse.

The descriptive statistics and frequencies of the adopted strategies are presented in Tables 2 and 3.

Among the coping strategies adopted by households in Tshwane, sticking to a budget was the most popular, followed by restricted eating among adults, borrowing food, buying only necessities, and eating smaller portions at mealtimes. These strategies were found to be frequent and repeatedly used by households. This aligns with previous studies by Yu et al. (2018) and Gupta et al. (2015). The food coping strategies observed in this study also support the findings of Asesefa Kisi et al. (2018), Bahta and Musara (2023), and Farzana et al. (2017).

EMPIRICAL FINDINGS

This section provides the empirical findings of the study. The first section offers the diagnostic tests, followed by the PCA findings.

TABLE 1 Descriptive statistics.

Variable	Total $N = 775$	Frequency (%)	Variable	Total $N = 775$	Frequency (%)
Age (years) - Mean; SD (38.6; 16,3)			Income - Mean; SD (4.81; 2.59)		
1. 18–30	253	33	0. No income	40	5
2. 31–39	202	26	1. R1–R400	26	3
3. 40–49	135	17	2. R401–R800	41	5
4. 50–59	80	10	3. R801–R1600	95	12
5. 60 and above	105	14	4. R1601–R3200	201	25
Gender - Mean; SD (1.63; 0.48)			5. R3201–R6400	105	13
Male	293	37.8	6. R6401–R12,800	79	10
Female	482	62.2	7. R12,801–R25,600	57	7
Social grant - Mean; SD (0.84; 1.12)			8. R25,601+	47	6
0. No grant	366	47	Household size - Mean; SD (3.92; 2.10)		
1. Child support	237	31	1. 1–2 members	198	25
2. Older person	150	19	2. 3 members	124	16
3. Disability	9	1.2	3. 4 members	129	16
4. Grant-in-aid	1	0.1	4. 5 members	114	14
5. Care	1	0.1	5. 6 members	69	9
6. War veterans	10	1.2	6. 7 members	38	5
7. Foster child	1	0.0	7. 8+ members	49	6

Source: Authors' calculations.

Diagnostic tests

To assess if the data is appropriate for PCA, we conducted Bartlett's Test of sphericity. This test compares an observed correlation matrix to the identity matrix and checks if the variables are orthogonal (not correlated). According to Tobias and Carlson (1969), it is a prerequisite for factor analysis. The results of Bartlett's Test are displayed in Table 4.

Bartlett's Test of Sphericity indicates that the variables are correlated $(774) = 148.56$ ($p < 0.001$). This implies that the PCA analysis can be used.

PCA findings

Table 5 displays the results of the PCA analysis, which utilized Promax rotation with Kaiser Normalization. Four components were extracted with Eigenvalues exceeding 1, accounting for a total variation of 68%. This indicates that the PCA was able to explain 68% of the household coping strategies.

TABLE 2 Common livelihood strategies: Statistics.

Coping Strategy Index	Mean	Std. Dev	Min	Max	Frequency	Total
Buy cheap, undesired food	0.49	0.78	0	2	377	2.85
Borrow food	1.59	1.85	0	8	1228	9.28
Eat smaller portions of meals	1.42	1.71	0	8	1101	8.32
Restrict eating by adults	1.59	1.93	0	8	1229	9.29
Skip meals	1.24	1.72	0	7	962	7.27
Buy food on credit	1.28	1.79	0	8	991	7.49
Loan for food	1.06	1.47	0	8	820	6.20
Buy only necessities	1.57	2.08	0	8	1216	9.19
Stick to budget	1.65	2.16	0	8	1278	9.66
Food garden	0.84	1.24	0	7	651	4.92
Member eating somewhere	0.89	1.44	0	7	689	5.21
Feed-only working members	0.87	1.44	0	8	670	5.07
Sent household members to beg	0.84	1.38	0	8	653	4.94
Gather wild vegetables, insects	0.88	1.50	0	8	682	5.16
Sold personal articles	0.88	1.46	0	8	681	5.15

Source: Authors' calculations.

Following the recommendation of Tabachnick and Fidel (1996), loadings greater than 0.4 can be meaningfully interpreted on the chosen components obtained from the PCA Promax Rotation analysis (Table 5). The loadings are reported in Table 6.

The first component comprises household members eating somewhere (0.916), feeding only working members (0.950), sending household members to beg (0.964), gathering wild vegetables and insects (0.947), and selling personal articles (0.943). The second component comprises households that adopt the following strategies: Restricting eating by adults (0.706), skipping meals (0.835), and buying food on credit (0.808). The third component comprises households that mostly borrow food (0.425), buy only necessities (0.885), and stick to the budget. Finally, the fourth component comprises households that buy cheap, undesired food (0.783), eat smaller portions at meal times (0.626), and maintain a food garden (0.494).

DISCUSSION

This section discusses the food coping strategies adopted by Tshwane's low-income households.

The descriptive findings from the adopted coping strategies showed that 22% of the households had a time when an adult had to skip a meal because there was not enough money to buy food. Overall, 45% of the households expressed some form of food distress.

The empirical findings from the PCA revealed that most households adopted four coping strategies in response to hunger. The first group, accounting for 32.6% of the total variation,

TABLE 3 Common livelihood coping strategies: Frequencies.

	In the past 7 days, if there have been times when you did not have enough food or money to buy food, how many days has your household had to:									
Coping Strategy Index (CSI)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**None**	**Frequency (%)**
Buy cheap, undesired food	97 (12.5)	140 (18.1)	-	-	-	-	-	-	538 (69.4)	377 (100)
Borrow food	359 (46.4)	61 (7.9)	45 (5.8)	25 (3.2)	31 (4.0)	15 (1.9)	37 (4.8)	1 (0.1)	201 (25.8)	1228 (100)
Eat smaller portions of meals	403 (52.1)	43 (5.6)	13 (1.7)	30 (3.9)	44 (5.7)	13 (1.7)	21 (2.7)	1 (0.1)	207 (26.6)	1101 (100)
Restrict eating by adults	352 (45.5)	55 (7.1)	38 (4.9)	16 (2.1)	38 (5.0)	36 (4.7)	18 (2.3)	43 (5.6)	217 (28.0)	1229 (100)
Skip meals	366 (47.3)	25 (3.2)	24 (3.1)	20 (2.6)	23 (3.0)	10 (1.3)	29 (3.4)	2 (0.3)	276 (35.6)	962 (100)
Buy food on credit	351 (45.4)	26 (3.4)	25 (3.2)	18 (2.3)	27 (3.5)	12 (1.6)	30 (3.9)	3 (0.4)	283 (36.4)	991 (100)
Loan for food	406 (52.5)	18 (2.3)	13 (1.7)	14 (1.8)	21 (2.7)	15 (1.9)	8 (1.0)	4 (0.5)	276 (35.5)	820 (100)
Buy only necessities	314 (40.6)	38 (5.0)	25 (3.2)	17 (2.2)	34 (4.4)	28 (3.6)	47 (6.1)	2 (0.3)	270 (34.8)	1216 (100)
Stick to budget	305 (39.4)	30 (3.9)	28 (3.6)	19 (2.5)	35 (4.5)	31 (4.0)	56 (7.2)	-	271 (35.0)	1278 (100)
Food garden	387 (50.0)	12 (1.6)	13 (1.7)	4 (0.5)	13 (1.7)	6 (0.8)	12 (1.6)	-	328 (42.3)	651 (100)
Member eating somewhere	406 (52.4)	14 (1.8)	5 (0.7)	4 (0.5)	3 (0.4)	6 (0.8)	3 (0.4)	19 (2.5)	315 (40.6)	689 (100)
Feed-only working members	408 (52.7)	4 (0.5)	6 (0.8)	3 (0.4)	3 (0.4)	6 (0.8)	3 (0.4)	19 (2.5)	323 (41.6)	670 (100)
Sent household members to beg	411 (53.1)	8 (1.0)	3 (0.4)	4 (0.5)	6 (0.8)	2 (0.3)	1 (0.1)	19 (2.5)	321 (41.3)	653 (100)
Gather wild vegetables, insects	405 (53.3)	8 (1.0)	2 (0.3)	4 (0.5)	3 (0.4)	4 (0.5)	-	25 (3.2)	324 (41.7)	682 (100)
Sold Personal articles.	411 (53.1)	9 (1.2)	3 (0.4)	5 (0.7)	3 (0.4)	3 (0.4)	2 (0.3)	22 (2.8)	317 (40.8)	681 (100)

Note: () shows the frequency of choosing a coping strategy in percentage.

Source: Authors' calculations.

TABLE 4 Bartlett's Test.

Kaiser–Meyer–Olkin measure of sampling adequacy.		0.764
Bartlett's Test of sphericity	Approx. Chi-square	148.56
	df	774
	Sig.	0.000

Source: Authors' calculations.

TABLE 5 PCA extraction.

	Initial eigenvalues			Extraction sums of squared loadings (SSL)			Rotation (SSL)
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.902	32.68	32.68	4.902	32.68	32.68	471
2	2.752	18.34	51.02	2.752	18.34	51.02	2968
3	1.317	8.78	59.80	1.317	8.78	59.80	2362
4	1.237	8.25	68.05	1.237	8.25	68.05	1645
5	0.834	5.56	73.61				
6	0.801	5.33	78.94				
7	0.698	4.653	83.60				
8	0.611	4.073	87.67				
9	0.491	3.272	90.94				
10	0.446	2.972	93.91				
11	0.353	2.352	96.27				
12	0.273	1817	98.08				
13	0.158	1.051	99.14				
14	0.075	0.5	99.64				
15	0.055	0.365	100				

Note: Extraction method: Principal component analysis.

consists of households that depend on begging and borrowing to survive. This group is considered to be in extreme poverty, according to Stats SA's report (2022). The national poverty lines are determined using the cost-of-basic needs approach, which links welfare to the consumption of goods and services. These lines include food and non-food items in a basket of household consumption expenses, as outlined in Stats SA's 2019 and 2023 reports. The lines have been benchmarked against inflation to determine the income needed for the minimum daily energy intake. Individuals living below the extreme poverty line earn less than R561 (US $35), while those falling between R561 (US$35) and R810 (US$50) are considered to be below the lower-bound poverty line. The upper bound poverty line applies to those earning between

TABLE 6 Promax rotated component matrix.

	Component			
Coping Strategy Index	**1**	**2**	**3**	**4**
Buy cheap, undesired food				0.783*
Borrow food			0.425*	
Eat smaller portions at meal times				0.626*
Restrict eating by adults.		0.796*		
Skip meals		0.835*		
Buy food on credit.		0.898*		
Loan for food				
Buy only necessities			0.885*	
Stick to the budget			0.890*	
Maintain food garden				0.494*
Members eating somewhere	0.916*			
Feeding only working members	0.950*			
Sent household members to beg	0.964*			
Gather wild vegetables, insects	0.947*			
Selling of personal articles	0.943*			

Note: Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.

A Rotation converged in five iterations.

*The significant loadings exceed +/−0.40

R1227 (US$75) and R810 (US$50) (Statistica, 2023). The group often gathers wild vegetables and insects and sells personal items to make ends meet. However, this behavior is not ideal, as Tsegaye et al. (2018) found that relying on wild plants indicates food insecurity and could negatively affect health.

The second group, accounting for 18.3% of the variation, comprises households using credit to purchase food, restricting meals to children, and skipping meals. This finding is supported by literature reports on Gauteng as reported by the Statistics South Africa (Stats, SA), (2016). According to the Community Survey, out of all nine provinces in South Africa, Gauteng had the highest percentage of households that relied on two food coping strategies—borrowing food and money (13.2%) and skipping meals (10.8%) (Statistics South Africa (Stats SA), 2016, pp. 86–88). The findings are congruent with Dlamini et al. (2023), who concurred that all coping strategies were used to some extent in South African households, with about 46% relying on less preferred and less expensive foods and 20.9% sending a household member to beg for food.

The credit purchase behavior is cushioned with some income. Fifty-three percent of the households rely on government social grants as their primary source of income. According to Zwane et al. (2022), the coverage of social contributions has increased significantly, with

around 17 million people (approximately 34% of the population) benefitting. Mackett (2020) concurred that households receiving grants are less likely to experience poverty than those without. Similarly, Nishimwe-Niyimbanira et al. (2021) argued that social grants could reduce poverty by almost 25% in Hlokozi, Kwazulu-Natal, South Africa. Despite their contribution to poverty reduction and food security, social grants alone are insufficient to meet primary household needs. Financial resources are spread thin, resulting in households skipping meals and continuously borrowing money in anticipation of payment from social grants in the following months (Devereux, 2017). Furthermore, Chakona and Shackleton (2019) argued that social grants do not significantly impact household food security due to insufficient funds to cover all the necessary expenses.

The third group, accounting for 8.8% of the total variation, consists of households in which a group of individuals frequently borrow money to purchase food. These individuals are typically from low-income households, prioritizing buying necessities and sticking to a budget. Along with lending money, these individuals also resort to selling assets to cushion against income shocks. However, these coping strategies can harm overall well-being. MENA Monitoring conducted surveys to determine the cost of well-being in Egypt, Jordan, Morocco, and Tunisia, assessing the compensation required to make up for the loss of earnings or employment and the coping strategies used to maintain well-being at the same level as those who did not use any coping strategies. The results showed that coping strategies involving losing earnings can have high costs and negatively impact well-being. Borrowing from banks and selling assets were found to be the most expensive coping strategies (Giovanis & Ozdamar, 2023).

It is essential to recognize that low-income individuals often face significant hurdles beyond financial struggles, such as debt and familial responsibilities. Unfortunately, these households may purchase cheaper and less desirable food to combat food insecurity and reduce meal portions. This can compromise their nutritional safety, as their food may lack the necessary dietary adequacy (Crush & Haysom, 2018; Mulamba, 2022).

The final group, with a total variation of 8.2%, comprises households that do not have food gardens and rely on buying cheap, undesired food that they eat in smaller portions during their meal times. According to Nickanor et al. (2023), the most effective coping strategies in Windhoek, Namibia, included consuming less preferred and cheaper foods, reducing the number of daily meals, and limiting portions during mealtimes. These findings could stem from constraints associated with establishing and sustaining home gardens and access to credit (Carstens et al. 2021; Galhena et al. 2013).

In support of the PCA findings, as alluded to in the four groups (components), the proportion of household income spent on food has gradually decreased from about 60% for those in the lowest-income quintile (households with income below the poverty line) (Mazenda, Molepo, et al. 2022). The findings further attest that the food sometimes lacks the nutrition requirements, and other unhealthy eating habits are difficult to leave. This is supported by Eicher-Miller et al. (2023), who highlighted that regardless of whether a person has the necessary knowledge and abilities, financial constraints, food accessibility, food preferences, eating habits, parental nutrition knowledge, parental modeling, and psychosocial factors, all have an impact on dietary decisions and may lead a person to choose food with lower cost over food with the highest nutritional value. Education and awareness are, therefore, essential interventions in addition to improving affordability and access to food to ensure improved nutrition and healthy safety in Tshwane.

CONCLUSIONS

This paper used Huston's social-ecological theory and the PCA analysis to identify food stress levels and coping mechanisms amongst low-income households in Tshwane, South Africa. The study findings showed that 32.6% of urban food-insecure households in Tshwane live in extreme poverty. The study also found that households adopt coping strategies in response to income shocks and struggle to make ends meet with limited resources. As a result, it is unlikely that households will change their coping strategies to adopt alternative approaches, which could compromise their nutritional safety. About 18.3% of households rely on credit, restrict adult eating, and skip meals. Together, these two components account for 50.9% of the total variation, highlighting the prevalence of extreme poverty in the city. Components three and four reflect households relying on government grants and low-income occupations. These findings align with existing literature on the characteristics of low-income households in Tshwane and other low-income urban households worldwide. Optimal solutions may involve providing income relief and improving disposable income to address these challenges.

POLICY IMPLICATIONS

The PCA has identified four categories of urban households experiencing food insecurity, each using different coping strategies to manage hunger. Despite their income levels, many households face obstacles such as debt and family obligations that limit their ability to reduce food expenses or improve the quality of their diet, putting their nutrition at risk.

In response to groups one and three, we propose the expansion of the Expanded Public Works Program mandate on poverty alleviation to all households in Tshwane. The program should link with industry to necessitate employment. This could draw lessons from successful initiatives such as the National Rural Youth Service Corps Program, a youth skills development and employment program. The Tshwane Metropolitan Municipality can equip residents with skills to start businesses while supporting the One-Stop Shop to market their products and protect specific industries in line with the Broad-Based Black Economic Empowerment framework. Adjusting wages for public works program participants, funding small and medium enterprises, increasing social security grants, and creating distress grants for households in extreme poverty can strengthen their buying power. Education on limiting household size through integrated health and family planning programs can also help reduce the financial burden of feeding a large family.

In response to group two, we recommend food policies that support food banks to deliver emergency food to food-insecure households. A revised qualification for the indigent program can be considered until most households are self-sufficient. Raising awareness of food security and coping strategies can increase access to safe and nutritious food and help alleviate poverty.

In response to group four, interventions should promote resilience and encourage sustainable agricultural practices at the household level to address food insecurity. The Tshwane Metropolitan Municipality can provide support by offering production inputs, such as vegetable seeds and production techniques, to encourage urban farming, including food and rooftop farming. Successful urban farming practices from other cities, such as Belgium, Singapore, the Netherlands, and France, can be used as a guide.

LIMITATIONS OF THE STUDY

This study captured the coping strategies of low-income households in Tshwane, often omitted in general household surveys. The sampling strategy used was representative of the population; however, a census is necessary.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data Share: https://doi.org/10.25403/UPresearchdata.16633576.v1.

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ENDNOTE

[1] This study was conducted in the Tshwane (Pretoria) Metropolitan Municipality. Tshwane Pretoria is the capital of South Africa, with a total population of 741,651 and an area of 687.5 km^2. Tshwane is part of the South African Gauteng Province. The province is divided into nine districts: Tshwane, Johannesburg, Ekurhuleni, Lesedi, Midvaal, Emfuleni, Merafong, Rand West, and Mogale. The province's total area is 18,176 km^2, with an approximate population of 2.9 million people.

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